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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/966,080	10/01/2001	Akifumi Kamijima	110735	5389

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EXAMINER	
RUGGLES, JOHN S	
ART UNIT	**PAPER NUMBER**
1756	7

DATE MAILED: 09/16/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

A 8-7

Office Action Summary	Application No.	Applicant(s)	
	09/966,080	KAMIJIMA ET AL.	
	Examiner	Art Unit	
	John Ruggles	1756	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Peri d f r Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *26 June 2003 and 14 April 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) _____ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-46* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *26 June 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) *5* .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Drawings

The newly corrected Figures 6 and 7 on replacement drawings sheets 2/8 and 3/8 were received on 26 June 2003 with Paper No. 6 in response to the previous objection of Paper No. 4. These newly corrected drawings are accepted and the previous objection is now withdrawn.

Claim Objections

Currently amended versions of the claims have overcome previous objections to the pending claims. Accordingly, these previous objections are now withdrawn.

Claim Rejections - 35 USC § 112

The previous rejection of claims 1-46 under the second paragraph of 35 U.S.C. 112 in Paper No. 4 has been overcome by the currently amended claims filed in Paper No. 6. Accordingly, this rejection is now withdrawn.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-2, 13, and 44-45 are rejected under 35 U.S.C. 102(b) as being anticipated by Kodama, et al. (US Patent 5,470,491).

Kodama teaches a method for manufacturing (method for fabricating) a thin film magnetic head (instant claim 45, micro device, instant claim 44) by photomechanical lithographic patterning of a thin film using a photoresist (resist) pattern (instant claim 13) at column 1, lines 14-28 and 43-44. The photoresist pattern (pre-resist pattern formed by exposing and developing) is used as an etching mask during etching (analogous to ashing or ash-treating) with a plasma of oxygen (O_2) and a freon (CF_4, SF_6, and/or CHF_3) (ashing treatment carried out by using a process gas composed of O_2 and at least one of a fluorine (F) based gas and a nitrogen (N_2)/hydrogen (H_2) gas mixture to shrink or narrow the photoresist pattern while etching), followed by ashing (ash-treating) to further shrink or narrow and remove the photoresist pattern (instant claims 1-2) at column 2, lines 34-39. The subsequent ashing to remove the photoresist is either by O_2 plasma alone (Example 1, column 8, lines 31-32) or by O_2 plasma with additional ion beam ashing (Example 3, column 9, line 62 to column 10, line 24). At column 10, lines 25-31, Kodama states that the additional ashing by ion beam offers the advantage that the profile of the patterned surface of the resist is transferred faithfully into the silicone surface (underlying layer being etched through the photoresist etching mask).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person

having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of Tseng, et al. (US Patent 5,811,358).

While teaching a method for fabricating a resist pattern by photolithographic patterning and ashing using a process gas composed of O_2 and a fluorine (F) based gas, Kodama does not specify ashing using a process gas having O_2 and a nitrogen (N_2)/hydrogen (H_2) gas mixture.

Tseng shows addition of a N_2/H_2 gas mixture (ratio about 4-96% N_2/H_2) to O_2 plasma during ashing of a photoresist pattern to increase the ashing efficiency at column 3, lines 4-5 and 61-66. The addition of H_2 plasma can effectively break chemical bonds in the photoresist to increase the reaction rate (column 4, lines 14-16).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to carry out the resist ashing as taught by Kodama with the alternative O_2 and N_2/H_2 gas mixture shown by Tseng to increase the ashing efficiency, because addition of H_2 plasma can effectively break chemical bonds in the photoresist to increase the reaction rate.

Claims 3-4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of Krounbi et al. (US Patent 5,604,073).

Kodama does not teach forming a polymethylglutarimide (PMGI) layer between the substrate and the resist pattern with subsequent partial removal of the PMGI by an alkaline water solution (bilayer resist process).

Krounbi discloses a bilayer lift-off photolithographic process for making lead conductors in a magnetoresistive (MR) sensor at column 3, lines 36-38. A polydimethylglutarimide (PMGI) release layer with an adhesion promoter additive is coated on a substrate, followed by overcoating with a diazonapthoquinone (DNQ)/Novolac (napthoquinonediazide/novolac) positive resist which is then exposed to the desired pattern and developed (bilayer resist process). During developing, the PMGI release layer is undercut from the edges of the resist pattern by an aqueous base developer (alkaline water solution) (column 3, lines 20-21, instant claims 3-4) to facilitate subsequent lift-off (column 1, lines 27-39); a long undercut provides the most effective lift-off (column 3, line 44). At column 2, lines 24-28, Krounbi states that bilayer lift-off processes are known in the art for producing well-defined patterns on a substrate surface using deposition techniques. Figures 1-4 as described at column 2, lines 29-47 show the process steps of developing the resist pattern (includes undercutting of the PMGI release layer), overcoating (layer 6 in Figure 3), and subsequent lift-off of the bilayer resist pattern by dissolving the PMGI release layer with an aqueous alkali or organic solvent.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the narrowed resist pattern formation by ashing to make a thin film magnetic head taught by Kodama with the bilayer lift-off photolithographic process using a release (bottom pattern) layer of PMGI partially removed during developing as disclosed by Krounbi in order to form an undercut at the base of the narrowed resist pattern for facilitating subsequent removal of the narrowed resist pattern during lift-off. This is because the bilayer process using PMGI as the release layer is stated by Krounbi to be known in the art for

producing well-defined deposition patterns on a substrate and a long undercut provides the most effective lift-off.

Claims 5, 16, 26, and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of Krounbi, further in view of Cohen et al. (US Patent 5,820,770), and further in view of Kamijima (US Patent 5,721,078).

Kodama and Krounbi do not specifically teach forming T-shaped or reversed trapezoid profile (longitudinal cross section) resist patterns and do not show subsequent milling using the resist pattern before lift-off.

Cohen shows a process of making a thin film magnetic head by: (1) metal plating through a suitable photoresist mask (column 6, lines 57-58), (2) vacuum deposition (e.g., sputtering, evaporation, etc.) with subsequent etching (ion milling (understood to be a sputter etching method) or reactive ion etching (RIE)) through a photoresist mask patterned by photolithography (column 7, lines 9-26 and 47-50), or (3) forming a plug 50 (e.g., photoresist, etc.) with negative sloped walls 52 (having an overhanging top with respect to the plug base) on a substrate (bonding pad 38) as shown in Figure 6 followed by sputtering an alumina layer 40 to leave a cap layer 40A on the plug 50, then lift-off of the cap layer 40A along with the plug 50 (photoresist) by etching or stripping (column 11, line 61 to column 12, line 7). At column 12, lines 1-4, Cohen points out that because sputtering is highly directional and anisotropic, the overhang created by the negative sloped walls 52 (of the photoresist pattern plug 50) leaves a gap between the lateral termination of alumina layer 40 and plug 50. Since ion milling is understood to be a sputter etching method, it would also be expected to be highly directional and anisotropic.

The negative sloped walls of the plug 50 are required in order to provide accessibility of a liquid etchant or stripper to the base of the plug 50 (photoresist pattern) during subsequent lift-off (column 12, lines 10-12). Cohen also suggests the equivalency of using a negative photoresist or a negatively toned (having a negative working agent or post-treated to reverse the image) positive photoresist for the patterned plug 50 at column 12, lines 16-18. The negative sloped walls of the photoresist plug can be achieved by using a plural layer (bilayer) resist process (column 12, lines 18-22). Alternatively, a metal plug having negative sloped walls can be made by plating metal through a resist pattern having an opening with positively sloped walls; the metal plug can be plated to a thickness well beyond that of the photoresist to cause the metal plug to spread (mushroom) over the photoresist (column 12, lines 22-30).

Kamijima teaches a magnetoresistance (MR) thin film element for a magnetic read head made by imaging (patterned exposure) of a novolak (novolac) positive resist having an alkali soluble phenol resin, a naphthoquinonediazide (napthoquinonediazide), and a negative working agent (to reverse the image) at column 1, lines 12-13, column 7, line 36 to column 8, line 35, and column 13, lines 38-40. The patterned resist is treated by heating (reversal baking causes an amine salt of carboxylic acid to quickly convert into an indene insoluble in aqueous base through a carbonyl removal reaction (decarbonylation, instant [0041]), column 11, lines 10-13), uniform exposure (flood exposure), and developing to leave the imaged (exposed) area as in the case of a negative resist at column 7, lines 40-43. The resist profile (longitudinal cross-section) is disclosed to be either a conventional reversed trapezoid as shown in Figures 2C-2D, 3, 5B-5C, and 8C-8E or alternatively T-shaped as shown in Figures 4, 7, and 10D, both of which are described at column 2, line 40 to column 3, line 52 and column 10, line 47 to column 11, line 40.

Kamijima also points out in Figure 12 as described at column 11, line 47 to column 13, line 34 the relationship between various process conditions and the resulting resist profile. After the desired resist profile was obtained, the resist pattern was etched (by ion milling) and/or coated (by sputtering) with a thin film followed by subsequent lift-off of the resist pattern at column 14, lines 23-24 and column 15, lines 52-55.

In the art of thin film magnetic head manufacture, it would have been obvious to one of ordinary skill in the art at the time the invention was made to manufacture a T-shaped profile (longitudinal cross-section) or alternative reversed trapezoid longitudinal cross-section by patterning a resist directly into this profile as shown by Kamijima because it affords the same overhang benefit for subsequent lift-off after directional coating as shown by Cohen for a reversed trapezoid cross-section. The overhang benefit with directional coating or etching (e.g., sputter coating or etching, ion milling, etc.) is to protect the resist base region from undesired coating (to facilitate subsequent lift-off) or etching.

Claims 6-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of either Chonan et al. (US Patent 4,444,869) or Kamijima.

Kodama does not teach forming a resist pattern using a picture reversion (negative acting) photoresist made by adding a negative working agent to a positive photoresist including a mixture of an alkaline soluble phenol resin and a napthoquinonediazide. Kodama also does not show heating and uniform exposure between patterned exposing and developing of the resist.

Chonan describes a photolithographic process for forming a negative resist pattern using a positive working resist (novolak (novolac) having a phenolic hydroxyl-containing monomer or

polymer (alkaline soluble phenol resin), including "naphtoquinonediazide" (napthoquinonediazide), column 2, lines 44-47 and column 3, lines 60-63). The negative resist pattern was formed by patterned exposure of the resist, heating (at 95°-150°C) to harden the exposed portion of the resist, blanket (uniform) exposure to decompose the nonexposed portion of the resist, and developing the reversed resist image (using an alkaline developer suitable for positive images) shown at column 4, line 63 to column 5, line 35 (achieves the same result as addition of a negative working agent to the positive resist). At column 5, lines 48-53, Chonan also states that this method forms a negative resist pattern (using a positive working resist) having a high definition, equivalent to that of a positive resist image which would have been obtained by positive working resist image formation without image reversal.

The teachings of Kamijima are discussed above.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to carry out the fabricating process of Kodama using the positive novolac photoresist having an alkaline soluble phenol resin and napthoquinonediazide along with heating and uniform exposure after patterned exposure described by either Chonan or Kamijima to reverse the image (form a negative image), because this process forms a negative resist pattern having a high definition as stated by Chonan.

Claims 9, 20, 30, and 40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of Cohen, and further in view of either Chonan or Kamijima.

Kodama does not teach forming T-shaped or reversed trapezoid profile (longitudinal cross section) resist patterns using a picture reversion (negative acting) photoresist made by

adding a negative working agent to a positive photoresist including a mixture of an alkaline soluble phenol resin and a napthoquinonediazide. Kodama also does not show heating and uniform exposure between patterned exposing and developing of the resist and does not show subsequent milling and/or thin film coating over the resist pattern with lift-off of the resist pattern.

The teachings of Cohen, Chonan, and Kamijima are discussed above.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to carry out the fabricating process of Kodama using the positive novolac photoresist having an alkaline soluble phenol resin and napthoquinonediazide along with heating and uniform exposure after patterned exposure described by either Chonan or Kamijima to reverse the image (form a negative image), because this process forms a negative resist pattern having a high definition as stated by Chonan. In the art of thin film magnetic head manufacture, it would have been obvious to one of ordinary skill in the art at the time the invention was made to manufacture a T-shaped profile (longitudinal cross-section) or alternative reversed trapezoid longitudinal cross-section by patterning a resist directly into this profile as shown by Kamijima because it affords the same overhang benefit for subsequent lift-off after directional coating as shown by Cohen for a reversed trapezoid cross-section. The overhang benefit with directional coating or etching (e.g., sputter coating or etching, ion milling, etc.) is to protect the resist base region from undesired coating (to facilitate subsequent lift-off) or etching.

Claims 10-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of Uenishi et al. (US Patent 4,894,311).

Kodama does not teach forming a resist pattern using a novolac positive photoresist including a phenol dissolution accelerator additive.

Uenishi shows a photolithographic process and a positive working photoresist (resist) composition containing an alkali-soluble novolak (novolac) resin, a photosensitive compound having plural napthoquinonediazido groups, and optionally a polyhydroxy (e.g., phenol, etc.) dissolution accelerator (additive) for this process at column 6, lines 5-14, column 2, lines 23-35, and column 5, lines 30-48. Uenishi specifies, at column 6, lines 46-63, the advantages of photolithography using this resist composition to include the following: excellent in high resolving power, faithful reproduction property, sectional shape of resist images, development latitude, and heat resistance.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to fabricate a narrowed resist pattern as taught by Kodama using a novolac positive resist having a photosensitive compound with plural napthoquinonediazido groups and a phenol dissolution accelerator as shown by Uenishi for the advantages of: high resolving power, faithful reproduction, sectional shape of resist images, development latitude, and heat resistance.

Claims 12, 23, 33, and 43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of Cohen, further in view of Kamijima, and further in view of Uenishi.

Kodama does not teach forming T-shaped or reversed trapezoid profile (longitudinal cross section) resist patterns using a novolac positive photoresist including a phenol dissolution accelerator additive. Kodama also does not show subsequent milling and/or thin film coating over the resist pattern with lift-off of the resist pattern.

The teachings of Cohen, Kamijima, and Uenishi are discussed above.

In the art of thin film magnetic head manufacture, it would have been obvious to one of ordinary skill in the art at the time the invention was made to manufacture a T-shaped profile (longitudinal cross-section) or alternative reversed trapezoid longitudinal cross-section by patterning a resist directly into this profile as shown by Kamijima because it affords the same overhang benefit for subsequent lift-off after directional coating as shown by Cohen for a reversed trapezoid cross-section. The overhang benefit with directional coating or etching (e.g., sputter coating or etching, ion milling, etc.) is to protect the resist base region from undesired coating (to facilitate subsequent lift-off) or etching. It would also have been obvious to one of ordinary skill in the art at the time the invention was made to fabricate a narrowed resist pattern as taught by Kodama using a novolac positive resist having a photosensitive compound with plural napthoquinonediazido groups and a phenol dissolution accelerator as shown by Uenishi for the advantages of: high resolving power, faithful reproduction, sectional shape of resist images, development latitude, and heat resistance.

Claims 14, 24, 34, and 46 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of Krounbi, and further in view of either Cohen or Kamijima.

Kodama does not teach forming a polymethylglutarimide (PMGI) layer between the substrate and the resist pattern with subsequent partial removal of the PMGI by an alkaline water solution (bilayer resist process). Kodama also does not show subsequent milling and/or thin film coating over the resist pattern with lift-off of the resist pattern.

The teachings of Kodama, Krounbi, Cohen, and Kamijima are discussed above.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the narrowed resist pattern formation by ashing to make a thin film magnetic head taught by Kodama with the bilayer lift-off photolithographic process using a release (bottom pattern) layer of PMGI partially removed during developing as disclosed by Krounbi in order to form an undercut at the base of the narrowed resist pattern for facilitating subsequent removal of the narrowed resist pattern during lift-off. This is because the bilayer process using PMGI as the release layer is stated by Krounbi to be known in the art for producing well-defined deposition patterns on a substrate and a long undercut provides the most effective lift-off. It would also have been obvious to use the bilayer lift-off resist (having overhang over undercut at the base region) process with milling and/or thin film coating by directional coating or etching (e.g., sputter coating or etching, ion milling, etc.) because the overhang protects the resist base region from undesired coating (to facilitate subsequent lift-off) or etching.

Claims 15, 25, and 35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of Krounbi, further in view of Cohen, and further in view of Tseng.

While Krounbi teaches forming a polymethylglutarimide (PMGI) layer between the substrate and the resist pattern with subsequent partial removal of the PMGI by an alkaline water solution (bilayer resist process) and Kodama in view of Cohen shows subsequent ashing with further milling and/or thin film coating followed by lift-off (as discussed above), they do not teach ashing by a process gas having O_2 and a nitrogen (N_2)/hydrogen (H_2) gas mixture.

The teachings of Tseng are discussed above.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to carry out the photolithographic process as shown by Kodama, Krounbi, and Cohen using resist ashing by an alternative O_2 and N_2/H_2 gas mixture shown by Tseng to increase the ashing efficiency, because addition of H_2 plasma can effectively break chemical bonds in the photoresist to increase the reaction rate.

Claims 17-18, 27-28, and 37-38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of Cohen, and further in view of either Chonan or Kamijima.

Kodama does not teach using a picture reversion photoresist (resist) made by adding a negative working agent to a positive photoresist including a mixture of an alkaline soluble phenol resin and a napthoquinonediazide and does not show heating and uniform exposure between patterned exposing and developing of the resist. Kodama also does not show subsequent milling and/or thin film coating over the resist pattern with lift-off of the resist pattern.

The teachings of Kodama, Cohen, Chonan, and Kamijima are discussed above.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to carry out the fabricating process of Kodama using the positive novolac photoresist having an alkaline soluble phenol resin and napthoquinonediazide along with heating and uniform exposure after patterned exposure described by either Chonan or Kamijima to reverse the image (form a negative image), because this process forms a negative resist pattern having a high definition as stated by Chonan. It would also have been obvious to use a resist profile (longitudinal cross-section) having overhang with directional coating or etching (e.g., sputter

coating or etching, ion milling, etc.), because the overhang protects the resist base region from undesired coating (to facilitate subsequent lift-off) or etching as pointed out by Cohen and discussed above.

Claims 19, 29, and 39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of Cohen, further in view of either Chonan or Kamijima, and further in view of Tseng.

While Kodama in view of either Chonan or Kamijima shows photolithographic patterning to form a narrowed resist pattern using a positive novolac photoresist having an alkaline soluble phenol resin and napthoquinonediazide along with heating and uniform exposure after patterned exposure described to reverse the image (form a negative image), then subsequent ashing with further milling and/or thin film coating followed by lift-off as taught by Cohen (discussed above); they do not teach ashing by a process gas having O_2 and a nitrogen (N_2)/hydrogen (H_2) gas mixture.

The teachings of Tseng are discussed above.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to carry out the photolithographic process as shown by Kodama, Chonan, and Cohen using resist ashing by an alternative O_2 and N_2/H_2 gas mixture shown by Tseng to increase the ashing efficiency, because addition of H_2 plasma can effectively break chemical bonds in the photoresist to increase the reaction rate.

Claims 21, 31, and 41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of Cohen, and further in view of Uenishi.

While teaching fabrication of a thin film by photoresist (resist) patterning and ashing followed by subsequent milling and/or thin film coating over the resist pattern with lift-off of the resist pattern, Kodama and Cohen do not teach using a novolac positive photoresist including a phenol dissolution accelerator additive.

The teachings of Uenishi are discussed above.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to fabricate a narrowed resist pattern (patterned thin film) as taught by Kodama and Cohen using a novolac positive resist having a photosensitive compound with plural napthoquinonediazido groups and a phenol dissolution accelerator as shown by Uenishi for the advantages of: high resolving power, faithful reproduction, sectional shape of resist images, development latitude, and heat resistance.

Claims 22, 32, and 42 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kodama in view of Cohen, further in view of Uenishi, and further in view of Tseng.

While Kodama and Cohen teach fabricating a thin film by photoresist (resist) patterning and ashing followed by subsequent milling and/or thin film coating over the resist pattern with lift-off of the resist pattern and Uenishi shows resist patterning using a novolac positive photoresist including a phenol dissolution accelerator additive, they do not show ashing by a process gas having O_2 and a nitrogen (N_2)/hydrogen (H_2) gas mixture.

The teachings of Tseng are discussed above.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to carry out the photolithographic process as shown by Kodama, Cohen, and Uenishi using resist ashing by an alternative O_2 and N_2/H_2 gas mixture shown by Tseng to increase the ashing efficiency, because addition of H_2 plasma can effectively break chemical bonds in the photoresist to increase the reaction rate.

Response to Arguments

Applicant's arguments filed 26 June 2003 in Paper No. 6 have been fully considered but they are not deemed persuasive. Applicants assert that Kodama does not narrow a previously formed resist pattern by subsequent ash-treating on page 15 of Paper No. 6. However, shrinking and narrowing of a preformed resist pattern are inherently known results caused by either ashing and/or etching as stated by Kodama and explained above. Merely stopping the ashing or etching at a time when the resist has been reduced to the desired size would be expected to result in applicant's narrowed resist. Also, Kodama teaches plural etching/ashing steps, the first of which would inevitably cause narrowing of the resist and the second of which would transfer the narrowed resist pattern into the underlying substrate by using the narrowed resist pattern as an etching mask. Therefore, the previous art rejections based on Kodama have been maintained. The other reasons for finding the pending claims as currently amended still anticipated and obvious over the cited prior art of record are explained above.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 703-305-7035. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 703-308-2464. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

John Ruggles
Examiner
Art Unit 1756

MARK F. HUFF
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700